

REMARKS

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow.

I. Disposition of the Claims

Claims 1, 22, 27, and 75 are currently being amended. No new matter has been added.

This amendment adds, changes and/or deletes claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier.

After amending the claims as set forth above, claims 1-20, 22, 24-30, 64, 68, 71, and 74-75 are now pending in this application.

II. Specification (Title)

Applicants have amended the title to be more descriptive as follows: “Electronic Component With At Least One N-Or P-Doped Portion”.

III. Objection to Claims 1 and 22

Applicants have appropriately amended claims 1 and 22 to obviate the objection.

IV. Anticipation And/Or Obviousness Over Yudasaka

The claims stand rejected as anticipated under 35 U.S.C. § 102(b) or obvious under § 103(a) over EP 1085578 (Yudasaka). Applicants respectfully traverse.

Anticipation requires disclosure of every limitation in a claim. M.P.E.P. § 2131 (“The identical invention must be shown in as complete detail as is contained in the ... claim.”) (quoting *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989)). “All words in a claim must be considered in judging the patentability of that claim against the prior art.” M.P.E.P. § 2143.03 (quoting *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970).

Yudasaka fails to disclose or suggest “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”.

Instead, Yudasaka discloses depositing a solution of compounds. Yudasaka nowhere discloses depositing particles of any kind. Yudasaka nowhere discloses depositing silicon or germanium in elemental form.

The Office cited paragraphs [0004], [0045], and [0066] to support the rejection of claims 1-3 over Yudasaka (Office Action, page 3):

In re claims 1-3, Yudasaka et al discloses a method of manufacturing an electronic component comprising at least one n- or p-doped portion, comprising the steps of: codepositing inorganic semi-conducting nanoparticles as a solid in liquid suspension and dopant on a substrate, the nanoparticles comprising silicon element or germanium element; fusing in situ on the substrate the nanoparticles by heating to form a continuous layer through a physical change of melting; and subsequently; recrystallizing the layer (paragraph 0004; paragraph 0045 - paragraph 0066).

The Yudasaka paragraphs [0004], [0045], and [0066] cited by the Office in the passage quoted above do not disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”:

[0004] However, the silicon film formed by the CVD method have involved some problems to be improved in the manufacturing process: (1) manufacturing yield is low due to contamination of the manufacturing apparatus and generation of foreign substances, since silicon particles appear in the gas phase to be used for the gas phase reaction, (2) a silicon film with a uniform thickness can not be deposited on a substrate having a rough surface, since a gaseous starting material is used, (3) a step for heating the substrate is required, and productivity is low due to a slow deposition rate of the film, and (4) a complicated and expensive microwave generator and an evacuation apparatus are necessary in the plasma CVD method.

[0045] While the solvents to be used in the present invention are not particularly limited, provided that they dissolve the silicon compound and do not react with the silicon compound,

examples of them include hydrocarbon solvents such as n-hexane, n-heptane, n-octane, n-decane, dicyclopentane, benzene, toluene, xylene, dulene, indene, tetrahydronaphthalene, decahydronaphthalene and squalane, as well as ether solvents such as dipropylether, ethyleneglycol dimethylether, ethyleneglycol diethylether, ethyleneglycol methylethylether, diethyleneglycol diethylether, diethyleneglycol methylethylether, tetrahydrofuran, tetrahydropyrane, 1,2-dimethoxyethane, bis(2-methoxyethyl)etheran p-dioxane; and polar solvents such as propylene carbonate, γ-butyrolactone, N-methyl-2-pyrrolidone, dimethylformamide, acetonitrile, dimethylsulfoxide and chloroform. Hydrocarbon solvents and ether solvents are preferable among these solvents from the point of solubility of the silicon compound and modified silicon compound and stability of the solution, and more preferable the solvent is a hydrocarbon solvent. These solvents may be used alone, or as a combination of two or more of these solvents. The hydrocarbon solvents are particularly suitable since they can improve solubility of the silicon compound and suppress residual compounds of the silicon compound by the heat-treatment or light irradiation treatment as will be described hereinafter.

[0066] Subsequently, a gate electrode 504 is formed from the liquid material. While a dope silicon film formed by using the liquid material, a metallic film formed by using a suspension solution of metal fine particles, or a metallic film formed by plating may be used for the gate electrode, an IT0 film formed with the liquid material was used in this example. At first, a coating film is formed on the substrate at a rotational speed of 1500 rpm using a 8% concentration of an organic compound containing indium and tin in xylene as a solvent. Then, the solvent was removed by heat-treating at 80°C, followed by a heat-treatment at 300°C to form a IT0 film with a thickness of 2000 Å. A gate electrode 504 as shown in Fig. 5(b) was formed in the next step by photo-etching. Resistivity of the IT0 film may be further reduced by taking out the substrate in the air after heat-treating at 300°C for 30 to 60 minutes, followed by cooling the substrate in a reducing atmosphere containing hydrogen at 200°C, desirably at 150°C.

These Yudasaka passages disclose using a solution of a silicone compound.

Applicants request that the Office explain by what interpretation these passages disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”.

Examples 1-3 of Yudasaka emphasize that a silicone compound is deposited as a solution. Example 1 discloses a solution of polysilazane:

[0083] In the next step, a gate insulation film 503 was formed using the liquid material as shown in Fig. 5(b). At first, a 5% polysilazane solution in xylene as a solvent was coated on the substrate at a rotational speed of 2000 rpm to form a coating film with a thickness of 1200 Å.

A solution of polysilazane is not a suspension of nanoparticles comprising silicon element or germanium element.

Example 2 refers to a “solution of the silane compound modified with phosphorous”:

[0090] In Fig. 6(a), the reference numeral 601 shows a glass substrate, and the reference numerals 602 and 603 show dope silicon films in which impurities to serve as source/drain regions are doped. A silane compound modified with phosphorous was used in forming the dope silicon film. A coating film is formed by coating the solution of the silane compound modified with phosphorous on the substrate by the spin-coating method.

A solution of a silane compound is not a suspension of nanoparticles comprising silicon element or germanium element.

Example 3 refers to a “a 55% solution of a mixture of cyclopentasilane and cyclohexasilane in benzene”:

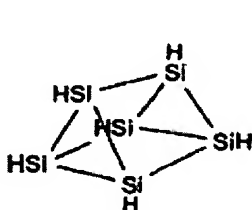
[0102] Subsequently, the silicon film 704 that serves as a channel layer is formed using the liquid material as shown in Fig. 7(c). At first, a 55% solution of a mixture of cyclopentasilane and cyclohexasilane in benzene as a solvent is used as a silicon compound to form a coating film at a rotational speed of 500 rpm.

A solution of cyclopentasilane and cyclohexasilane is not a suspension of nanoparticles comprising silicon element or germanium element.

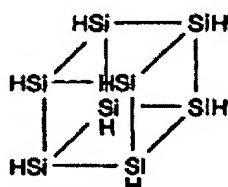
Applicants have amended claim 1 to more clearly point out that the nanoparticles contain silicon or germanium as elements, i.e., in elemental form. The meaning of “element” is apparent to a person of ordinary skill in the art. A dictionary definition of “element” is “any of the fundamental substances that consist of atoms of only one kind” (Merriam-Webster Online Dictionary. 2008).

Yudasaka does not disclose or suggest “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension and dopant on a substrate, the nanoparticles comprising silicon element or germanium element”. Instead, Yudasaka discloses applying a solution of a silicon compound.

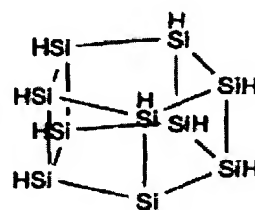
Yadusaka fails to disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”. Instead, Yadusaka discloses depositing solutions of the following exemplary compounds 1-27:



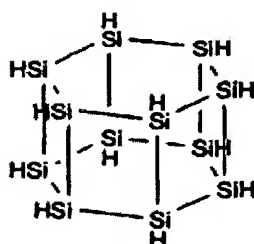
Compound 1



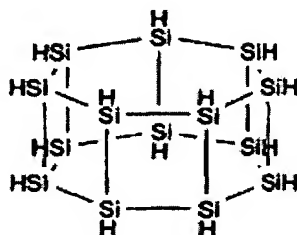
Compound 2



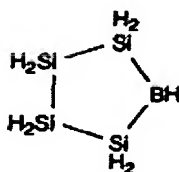
Compound 3



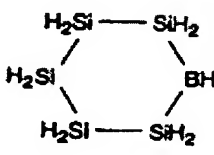
Compound 4



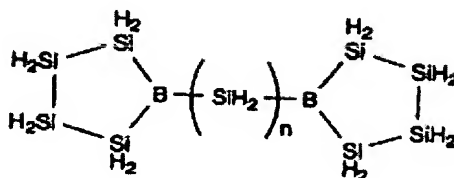
Compound 5



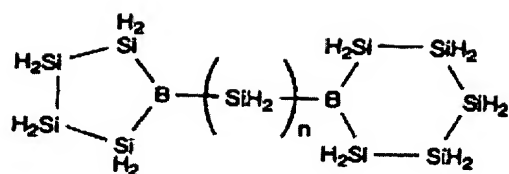
Compound 6



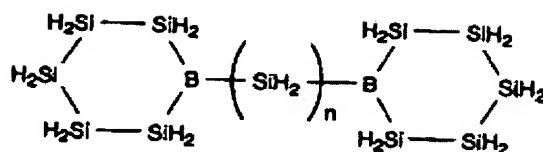
Compound 7



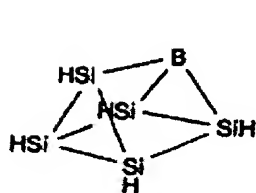
Compound 8



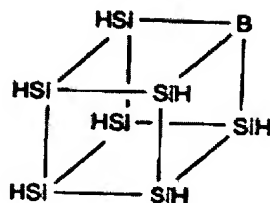
Compound 9



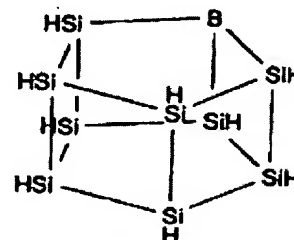
Compound 10



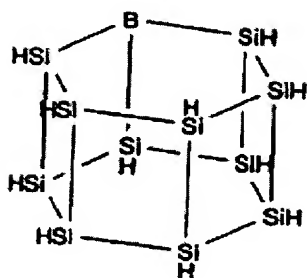
Compound 11



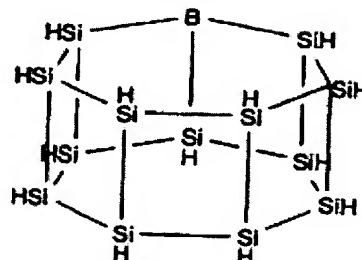
Compound 12



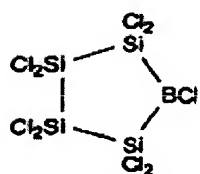
Compound 13



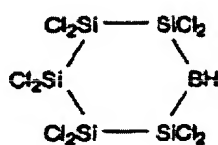
Compound 14



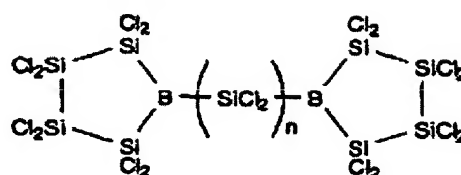
Compound 15



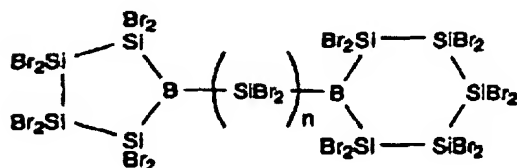
Compound 16



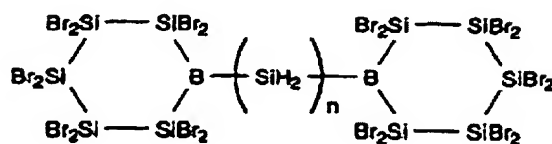
Compound 17



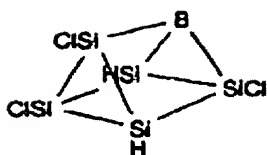
Compound 18



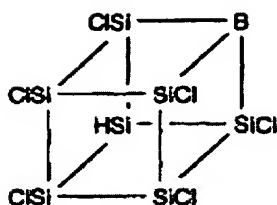
Compound 19



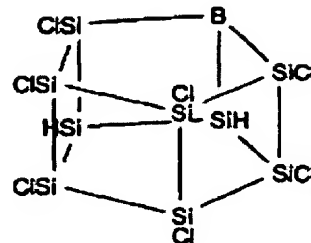
Compound 20



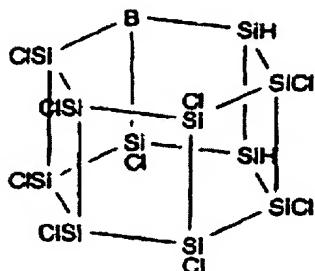
Compound 21



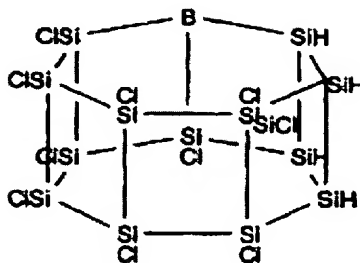
Compound 22



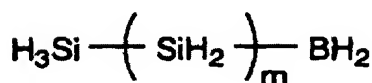
Compound 23



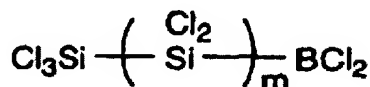
Compound 24



Compound 25



Compound 26



Compound 27

Compounds 1-27 are compounds. Compounds 1-27 are not a “silicon element or germanium element”. Accordingly, Yudasaka cannot anticipate the present claims.

Yudasaka nowhere suggests “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension and dopant on a substrate, the nanoparticles comprising silicon element or germanium element”. To the contrary, Yudasaka emphasizes that it is important to use a solution, and Yudasaka refers repeatedly to “compounds” and never mentions elemental silicon or germanium.

Accordingly, Yudasaka would not have rendered obvious the present claims.

Applicants request that the Office withdraw the rejection over Yudasaka.

V. Anticipation And/Or Obviousness Over Furusawa

The claims stand rejected as anticipated under 35 U.S.C. § 102(b) or obvious under § 103(a) over WO 2000/059044 (Furusawa). Applicants respectfully traverse.

The Office has not provided a translation of Furusawa and relies instead on its national phase U.S. Patent No. 6,518,087. The information available on Public PAIR does not indicate that a certified translation of WO 2000/059044 was submitted during prosecution of U.S. Patent No. 6,518,087. Absent such confirmation that U.S. Patent No. 6,518,087 is an accurate translation of WO 2000/059044, Applicants request that the Office obtain a certified translation.

Assuming that U.S. Patent No. 6,518,087 is an accurate translation, Furusawa is nevertheless deficient as prior art for anticipation or obviousness for reasons similar to those given for Yudasaka.

Anticipation requires disclosure of every limitation in a claim. M.P.E.P. § 2131 (“The identical invention must be shown in as complete detail as is contained in the ... claim.”) (quoting *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989)). “All words in a claim must be considered in judging the patentability of that claim against the prior art.” M.P.E.P. § 2143.03 (quoting *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970)).

Furusawa fails to disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”.

Instead, Furusawa discloses depositing a solution of compounds. Furusawa nowhere discloses depositing particles of any kind. Furusawa nowhere discloses depositing silicon or germanium in elemental form. The Office cited columns 9-12 of Furusawa to support the rejection of claims 1-3 (Office Action, paragraph bridging pages 5-6):

In re claims 1-3, Furusawa et al discloses a method of manufacturing an electronic component comprising at least one n- or p-doped portion, comprising the steps of: codepositing inorganic semi-conducting nanoparticles as a solid in liquid suspension and dopant on a substrate, the nanoparticles comprising silicon element or germanium element; fusing in situ on the substrate the nanoparticles by heating to form a continuous layer through a physical change of melting; and subsequently; recrystallizing the layer (column 9 - column 12).

The Furusawa columns 9-12 cited by the Office in the passage quoted above do not disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”:

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In the method of the present invention, a solution is coated on a substrate, which is composed of a solvent dissolving a silicon compound (a non-modified silane compound) represented by the formula Si_nX_m and a silicon compound represented by the formula $\text{Si}_n\text{X}_p\text{Y}_q$ (a modified silane compound). The solvent used in the present invention generally has a vapor pressure of 0.001 to 200 mm Hg at room temperature. When the vapor pressure of a solvent is more than 200 mm Hg, since the solvent is vaporized before a coating film is formed, it is difficult to form a superior coating film. On the other hand, when the vapor pressure of a solvent is less than 0.001 mm Hg, since drying is slow and the solvent easily tends to remain in the coating film, a superior coating film composed of a silicon compound and a modified silicon compound is difficult to obtain even by heating and/or light irradiation in the following step.

A solvent used in the present invention is not specifically limited so long as the solvent dissolves the silane compound described above and/or the modified silane compound described above and will not react with the solute dissolved therein. As examples of the solvents, in addition to hydrocarbon solvents, such as n-pentane, n-hexane, n-heptane, n-octane, n-decane, dicyclopentane, benzene, toluene, xylene, durene, indene, tetrahydronaphthalene, decahydronaphthalene, and squalane, there may be mentioned, for example, diethyl ether, dipropyl ether, ethyleneglycol dimethyl ether, ethyleneglycol diethyl ether, ethyleneglycol methyl ethyl ether, diethyleneglycol dimethyl ether, diethyleneglycol diethyl ether, diethyleneglycol methyl ethyl ether, tetrahydrofuran, tetrahydropyran, p-dioxane, and tetrahydrofuran as ether solvents, and propylene carbonate, γ -butyrolactone, N-methyl-2-pyrrolidone, dimethylformamide, acetonitril, dimethyl sulfoxide, methylene chloride, and chloroform as polar solvents. Among those mentioned above, in view of solubility of silane compounds and stability of the solution, hydrocarbon solvents and ether solvents are preferable, and as more preferable solvents, hydrocarbon solvents may be mentioned. These solvents may be used alone or in combination. In particular, hydrocarbon solvents are preferable since solubility of a silicon compound is improved and remaining thereof during heating or light irradiation, described later, is suppressed.

As the coating composition used in the present invention, a composition only containing the non-modified silicon compound described above as a solute, a composition only containing the modified silicon compound described above, or a composition containing both silicon compounds may be used. A coating composition can be optionally prepared in accordance with a desired coating method and a desired silicon thickness, which is composed of the solvent mentioned above and generally has a solute at a concentration of approximately 1 to 80%. The solution thus prepared containing the modified silicon compound has a viscosity of 1 to 500 mPa·s. When the viscosity is less than 1 mPa·s, coating is difficult to perform, and when the viscosity is more than 500 mPa·s, it is difficult to obtain a coating film having a smooth surface. In particular, when coating is performed by an inkjet printer head, the viscosity is preferable 1 to 50 mPa·s.

The solution described above may contain a small amount of a surface tension adjuster, such as a fluorine-based, a silicone-based, or a nonionic adjuster, so long as the objective functions are not degraded. The nonionic surface tension adjuster is effective to improve wettability of the solution on a material to be coated, to improve leveling properties of the coated film, and to prevent the coated film from forming a concavo-convex form and an orange skin-like surface, i.e., a rough surface.

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In steps for forming silicon films used for the method for manufacturing a solar battery of the present invention, gases are not supplied differing from the case of CVD methods which are generally employed, but after the liquid coating composition described above is coated on a substrate, a coating film is formed by evaporating the solvent, and the coating film is converted into a silicon film by pyrolysis and/or photolysis, or the coating film is converted into a polycrystalline silicon film by pyrolysis and/or photolysis followed by laser treatment.

In addition, without performing ion implantation in vacuum on the silicon film modified by boron atoms or phosphorus atoms, a p-type or an n-type silicon film is formed. As a coating method of the coating composition described above, a spin coating method, a roll coating method, a curtain coating method, a dip coating method, a spray coating method, an inkjet method, or the like may be used. Coating is generally performed at room temperature or above. When coating is performed at below room temperature, solubility of silane compound is decreased, and hence, some of the silane compound may be precipitated in some cases. An environment in which coating is performed is preferably an inert gas atmosphere, such as nitrogen, helium, or argon. In addition, when necessary, a reducing gas, such as hydrogen, is preferably mixed therewith. When a spin coating method is used, the rotation rate of a turntable is determined by the thickness of a thin film to be formed and the coating composition; however, in general, the number of rotation is 100 to 5,000 rpm, preferably, 300 to 3,000 rpm. After coating, heating is performed in order to remove the solvent. The heating temperature changes in accordance with the type of solvent, and the boiling point thereof; however, in general, it is 100 to 200° C. An environment is preferably an atmosphere of inert gas, such as nitrogen, helium, or argon, as is the case with the coating step described above.

The coating composition used in the present invention is a composition to be converted into a silicon film by heating and/or light irradiation from a coating film of the composition formed beforehand, and the silicon film obtained thereby is composed of amorphous or polycrystalline silicon. In the step of heating, in general, when a maximum temperature is 550° C. or less, an amorphous silicon film is obtained, and when a maximum temperature is above 550° C., a polycrystalline silicon film is obtained. In order to obtain an amorphous silicon film, the temperature is preferably 300 to 550° C., and the temperature is more preferably 350 to 500° C. When a maximum temperature is less than 300° C., pyrolysis of a silane compound may not proceed sufficiently, and hence, a silicon film provided with satisfactory properties may not be obtained in some cases. As an environment in which heating is performed, an inert gas atmosphere, such as nitrogen, helium, or argon, or an atmosphere containing a reducing gas, such as hydrogen, is preferable. In order to obtain a polycrystalline silicon film, the amorphous silicon film thus obtained can be converted into a polycrystalline silicon film by irradiating a laser. An environment, in which laser irradiation is performed, is preferably an atmosphere containing no oxygen, such as an inert gas atmosphere of nitrogen, helium, argon, or the like, or an atmosphere of the inert gas mentioned above containing a reducing gas, such as hydrogen.

Light treatment can be performed on a coating film composed of the composition (solution) containing a silicon compound in an inert gas atmosphere before the solvent is removed and/or after the solvent is removed. A solvent-soluble silicon compound is not only converted into a

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solvent-insoluble rigid coating film by a reaction induced by light treatment, but also, it can be converted into a silicon film having superior optical electric properties by light treatment or by light treatment performed simultaneously with heating.

As a light source used in irradiation, in addition to a low pressure or a high pressure mercury lamp, a deuterium lamp, and a discharge light of a rare gas, such as argon, krypton, or xenon, YAG laser, argon laser, carbon dioxide laser, or excimer laser of, such as XeF, XeCl, XeBr, KrF, KrCl, ArF, or ArCl, may be mentioned. A light source having an output of 10 to 5,000 W is generally used; however, an output of 100 to 1,000 W is commonly sufficient. The wavelength of the light source is not specifically limited so long as it is absorbed to some extent in a silicon compound contained in the coating composition described above; however, the wavelength thereof is generally 170 to 600 nm, and in particular, a wavelength of 170 to 380 nm is preferable in view of absorption efficiency. In addition, in view of conversion efficiency into a silicon film, in particular, laser light is preferably used. A temperature during irradiation is normally room temperature to 500° C., and a temperature is optionally determined in accordance with semiconductor characteristics of a silicon film to be obtained.

A substrate which is coated with a coating composition used in the present invention is not specifically limited. As a substrate which can be used, there may be mentioned, in addition to a common quartz, borosilicate glass, and soda-lime glass, a metal substrate, such as gold, silver, copper, nickel, titanium, aluminum, or tungsten, and glass substrate and a plastic substrate, which are provided thereon with a conductive metal layer composed of the metal mentioned above or with a conductive metal oxide film such as ITO.

An apparatus for carrying out the method of the present invention described above is schematically shown in FIG. 1 and FIGS. 2(a)–2(c). FIG. 1 is an example of an apparatus provided with a spin coater 11 and an infrared lamp 14 in an inert gas atmosphere. In the inert gas atmosphere, such as a nitrogen gas atmosphere, a coating composition containing the silane compound described above is dripped on a substrate 12, is uniformly coated by the spin coater 11, and is then dried. Subsequently, the composition thus coated is heated at predetermined conditions by the infrared lamp 14, whereby an amorphous silicon thin film 13 can be formed. Impurity concentration and conductive characteristics of the silicon thin film 13 can be controlled by a mixing ratio of the silane compound and the modified silane compound contained in the coated coating composition. In addition, the thickness of the silicon thin film can be controlled by the rotation rate of the spin coater, viscosity of the solution, concentration thereof, and the like.

FIGS. 2(a)–2(c) show schematic views of an example of an apparatus for forming an amorphous silicon film, in which a droplet 26 of the coating composition 25 described above containing a silane compound is coated on a substrate 22 using an inkjet printer head 24 in an inert gas atmosphere, and the coating is simultaneously patterned (FIG. 2a), the coating composition 27 coated on the substrate is then dried so as to remove the solvent (FIG. 2b), and subsequently, by heating the substrate on a hot plate 21, an amorphous silicon film 28 is formed (FIG. 2c). When the solution is coated by the inkjet printer head, since coating can be uniformly performed only on desired locations, there is a feature which can minimize the amount of the starting material to be used. In addition, in this step, the film thickness thereof can be controlled by operating conditions of the printer head and the concentration and viscosity of the solution.

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A solar battery generally has a structure in which at least 2 layers, which are selected from an i-type, a p-type, and an n-type semiconductor thin film, are provided between a pair of electrodes so as to form a semiconductor junction, such as pn, pin, ip, and in. Also, in the method for manufacturing a solar battery of the present invention, in order to form semiconductor junctions as mentioned above, by repeatedly performing the method described above for forming a silicon thin film of an i-type, a p-type, or an n-type, an optional semiconductor junction can be formed.

Electrodes, conductive films for wiring, and when necessary, insulating films to be used, which are used in the solar battery in the present invention, are not specifically limited. For example, a metal film which is usually used for a solar battery, a transparent conductive film such as ITO, and an insulating film composed of, for example, SiO₂, can be used. In addition, as forming methods therefor, a common deposition method, a sputtering method, and a CVD method can be used. However, in consideration of the feature of the method of the present invention in which a silicon film is formed by a liquid material that requires no vacuum process, formations of conductive films and insulating films are preferably performed by liquid materials that require no vacuum process. As a method for forming a conductive film by a liquid material, there may be mentioned, for example, a method using a slurry having metal particles dispersed in an organic solvent, a plating method, and a method for forming an ITO thin film by heating after coating an organic compound containing indium and tin. As a method for forming an insulating film, a method may be mentioned as an example, in which, after a polysilazane is coated on a substrate, the coating film thereof is converted into a film composed of SiO₂ by heating.

In the method for manufacturing a solar battery of the present invention, the silicon film, the conductive film, and the insulating film, may be patterned in some cases after these films are formed, and as a method for patterning, a common method, such as a mask method or a lithographic method, may be used. However, in consideration of the feature of the present invention in which a film is formed by coating a liquid material, it is particularly preferable that coating of a liquid material and patterning thereof be simultaneously performed by using an inkjet printer head. According to an inkjet method, since an amount of a starting material to be used can be minimized, it is particularly effective in reducing the manufacturing cost of the solar battery. In addition, when the electrodes, conductive films, and the insulating films are formed by using liquid materials, it is particularly preferable that coating and patterning be simultaneously performed by an inkjet method.

Hereinafter, the present invention will be described in detail with reference to examples; however, the present invention will not be limited thereto.

EXAMPLE 1

On a quartz substrate (31) having a transparent conductive film ITO (32) formed thereon, a solar battery having a structure schematically shown in FIG. 3 was formed in accordance with Steps 1-1 to 1-4 described below. (Step 1-1)

In order to form a p-type silicon film, 1 mg of a boron modified silane compound, i.e., 1-borahexaprismane (compound 14), and 1 g of cyclohexasilane were dissolved in 20 g of toluene, thereby preparing a coating solution. The viscosity thereof was 5.5 mPa·s. The solution was spin-coated in an argon atmosphere on the quartz substrate 31

These Furusawa passages disclose using a solution of a silicone compound. Applicants request that the Office explain by what interpretation these passages disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”. The following passage in column 9 of Furusawa is illustrative:

9

In the method of the present invention, a solution is coated on a substrate, which is composed of a solvent dissolving a silicon compound (a non-modified silane compound) represented by the formula Si_nX_m and a silicon compound represented by the formula $Si_aX_bY_c$ (a modified silane compound). The solvent used in the present invention gen-

...

As the coating composition used in the present invention, a composition only containing the non-modified silicon compound described above as a solute, a composition only containing the modified silicon compound described above, or a composition containing both silicon compounds may be used. A coating composition can be optionally prepared in accordance with a desired coating method and a desired silicon thickness, which is composed of the solvent mentioned above and generally has a solute at a concentration of approximately 1 to 80%. The solution thus prepared containing the modified silicon compound has a viscosity of 1 to 500 mPa·s. When the viscosity is less than 1 mPa·s, coating is difficult to perform, and when the viscosity is more than 500 mPa·s, it is difficult to obtain a coating film having a smooth surface. In particular, when coating is performed by an inkjet printer head, the viscosity is preferable 1 to 50 mPa·s.

The solution described above may contain a small amount of a surface tension adjuster, such as a fluorine-based, a silicone-based, or a nonionic adjuster, so long as the objective functions are not degraded. The nonionic surface ten-

Moreover, Furusawa applies the solution by inkjet printing, a method that one would not expect to work with a suspension, because suspended particles would clog inkjet nozzles.

Furusawa emphasizes the need for a solution (column 5, lines 10-19 and column 6, lines 53-62). The Examples in Furusawa emphasize that a silicone compound is deposited as a solution. Example 1 states (columns 12-13):

In order to form a p-type silicon film, 1 mg of a boron modified silane compound, i.e., 1-borahexaprismane (compound 14), and 1 g of cyclohexasilane were dissolved in 20 g of toluene, thereby preparing a coating solution. The viscosity thereof was 5.5 mPa·s. The solution was spin-coated in an argon atmosphere on the quartz substrate 31

...

Next, in order to form an i-type silicon film, 2 g of 1,1'-biscyclopentasilane was dissolved in a mixed solvent of 10 g of toluene and 10 g of xylene, thereby preparing a coating solution. The viscosity of the solution was 6.5 mPa·s. The solution was spin-coated on the substrate

...

Next, in order to form an n-type silicon film, 1 mg of phosphorous modified silane compound, i.e., 1-phosphocyclopentasilane, and 1 g of octasilacubane (compound 2) were dissolved in a mixed solvent of toluene in an amount of 10 g and tetrahydronaphthalene, thereby preparing a coating solution. The viscosity of the solution was 7.2 mPa·s. The solution was spin-coated in an argon

Example 2 states (columns 13-14):

A solution was prepared which has a viscosity of 5 mPa·s formed of 1 mg of a boron modified silane compound, i.e., 1-boraoctasilacubane (compound 12), and 1 g of silylcyclopentasilane dissolved in 20 g of toluene. The solution thus formed was spin-coated on a substrate in an argon atmosphere containing 3% hydrogen, and while being dried at

...

A solution was prepared which has a viscosity of 7 mPa·s formed of 1 g of 1,1'-biscyclohexasilane and 1 g of 1,1'-biscyclopentasilane dissolved in 20 g of tetrahydronaphthalene. The solution thus formed was spin-coated on the

...

By using a solution having a viscosity of 6.5 mPa·s obtained by dissolving 1 mg of a mixture formed of 1-phosphocyclohexasilane and 1-phosphocyclopentasilane in 20 g of toluene, the same processing was performed as was described in Step 1-3, thereby yielding an n-type amorphous silicon film.

Example 3 states (column 13):

By using a solution having a viscosity of 3.2 mPa·s obtained by dissolving 1 mg of 1-boracyclopentasilane (compound 6 described above) and 1 g of cyclopentasilane in a mixed solvent of 30 g of tetrahydronaphthalene and 10 g of decahydronaphthalene, the same processing was per-

...

By using a solution having a viscosity of 3.2 mPa·s obtained by dissolving 1 g of cyclohexasilane in a mixed solvent of 30 g of tetrahydronaphthalene and 10 g of decahydronaphthalene, the same processing was performed

...

By using a solution having a viscosity of 3.2 mPa·s obtained by dissolving 1 mg of 1-phosphocyclopentasilane and 1 g of cyclopentasilane in a mixed solvent of 30 g of tetrahydronaphthalene and 10 g of decahydronaphthalene, the same processing was performed as was described in Step

The solutions of various silane compounds described in the Furusawa Examples quoted above are not suspensions of nanoparticles comprising silicon element or germanium element.

Applicants have amended claim 1 to more clearly point out that the nanoparticles contain silicon or germanium as elements, i.e., in elemental form. The meaning of “element” is apparent to a person of ordinary skill in the art. A dictionary definition of “element” is “any of the fundamental substances that consist of atoms of only one kind” (Merriam-Webster Online Dictionary. 2008).

Furusawa does not disclose or suggest “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension and dopant on a substrate, the nanoparticles comprising silicon element or germanium element”. Instead, Furusawa discloses applying a solution of silicon compounds.

Furusawa fails to disclose “co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension . . . the nanoparticles comprising silicon element or germanium element”. Instead, Furusawa discloses depositing solutions of compounds described as follows (column 5, lines 1-36):

5

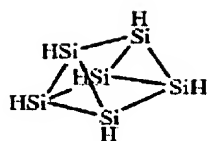
A liquid coating composition used in a method for manufacturing a solar battery of the present invention, may consist of a cyclic silicon compound, and in particular, a silane compound preferably represented by the formula Si_nX_m (the subscript n stands for an integer of 5 or more, the subscript m stands for an integer of n , $2n-2$, or $2n$, and X stands for a hydrogen atom and/or halogen atom).

In particular, as the silicon compound represented by the formula Si_nX_m , the subscript n is preferably 5 to 20, and the subscript n is more preferably 5 or 6. When the subscript n is less than 5, the silicon compound itself is unstable by strain generated by the cyclic structure thereof, so that the handling thereof is difficult, and when the subscript n is more than 20, the solubility of the silicon compound is decreased due to the cohesion force thereof, and it becomes difficult to select a usable solvent in practice.

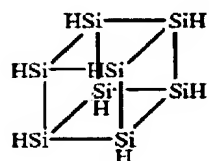
As particular examples of the silicon compound, there may be mentioned cyclopentasilane, silylcyclopentasilane, cyclohexasilane, silylcyclohexasilane, and cycloheptasilane as a silane compound having one cyclic structure, and 1,1'-biscyclobutasilane, 1,1'-biscyclopentasilane, 1,1'-biscyclohexasilane, 1,1'-biscycloheptasilane, 1,1'-cyclobutasilylcyclopentasilane, 1,1'-cyclobutasilylcyclohexasilane, 1,1'-cyclobutasilylcycloheptasilane, 1,1'-cyclopentasilylcyclohexasilane, 1,1'-cyclopentasilylcycloheptasilane, 1,1'-cyclohexasilylcycloheptasilane, spiro[2,2]pentasilane, spiro[3,3]heptasilane, spiro[4,4]nonasilane, spiro[4,5]decasilane, spiro[4,6]undecasilane, spiro[5,5]undecasilane, spiro[5,6]dodecasilane, and spiro[6,6]tridecasilane as a silane compound having two cyclic structures.

Furusawa also discloses the following exemplary compounds 1-27:

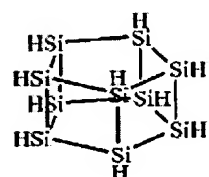
Compound 1



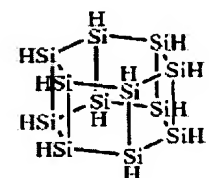
Compound 2



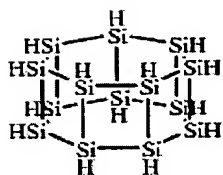
Compound 3



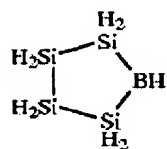
Compound 4



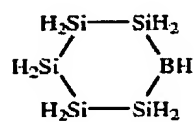
Compound 5



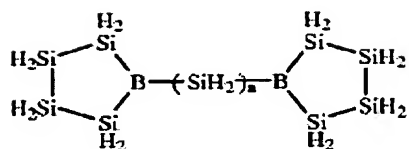
Compound 6



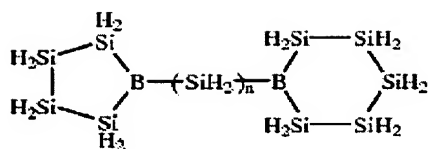
Compound 7



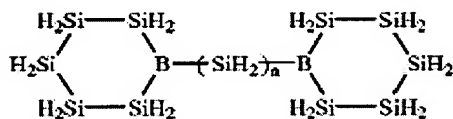
Compound 8



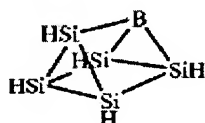
Compound 9



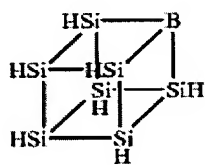
Compound 10



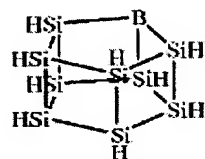
Compound 11



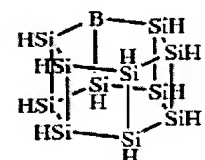
Compound 12



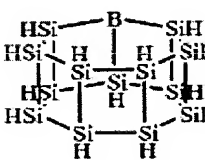
Compound 13



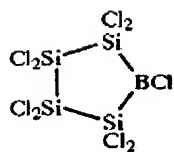
Compound 14



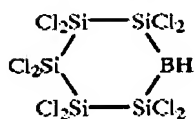
Compound 15

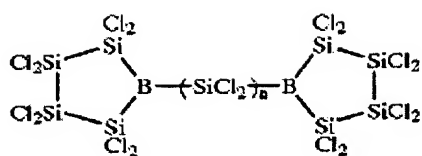


Compound 16

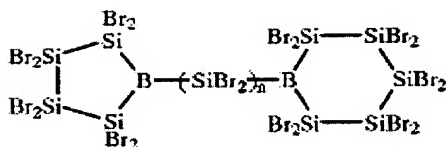


Compound 17

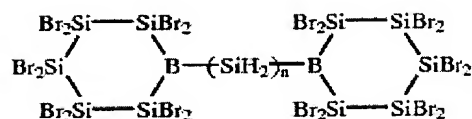




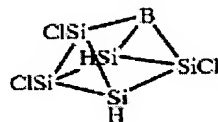
Compound 18



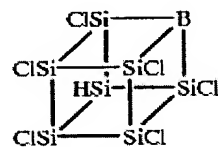
Compound 19



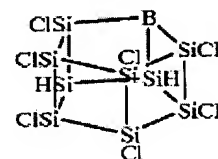
Compound 20



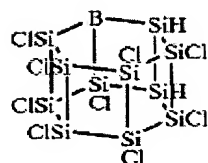
Compound 21



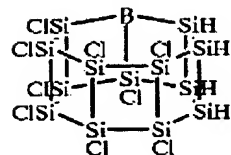
Compound 22



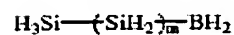
Compound 23



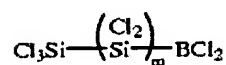
Compound 24



Compound 25



Compound 26



Compound 27

Compounds 1-27 are compounds. Compounds 1-27 are not a "silicon element or germanium element". Accordingly, Furusawa cannot anticipate the present claims.

Furusawa nowhere suggests "co-depositing inorganic semi-conducting nanoparticles as a solid in liquid suspension and dopant on a substrate, the nanoparticles comprising silicon element or germanium element". To the contrary, Furusawa emphasizes that it is important to use a solution, and Furusawa refers repeatedly to "compounds" and never mentions elemental silicon or germanium.

Accordingly, Furusawa would not have rendered obvious the present claims.

Applicants request that the Office withdraw the rejection over Furusawa.

CONCLUSION

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.


The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 C.F.R. § 1.25. Additionally, charge any fees to Deposit Account 08-2025 under 37 C.F.R. § 1.16 through § 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees.

Respectfully submitted,

Date September 24, 2008

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